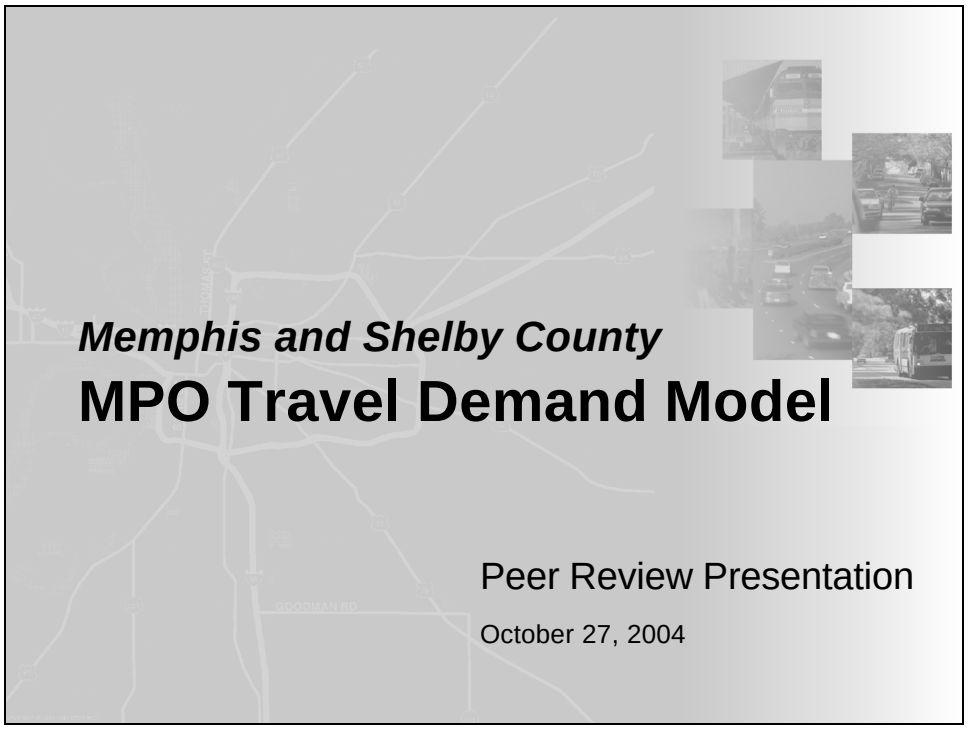


Memphis and Shelby County

MPO Travel Demand Model

Peer Review Presentation

October 27, 2004

Introduction

Ground Rules

- Big Picture Input
- Stay out of the “weeds”
- Methodology and Process have been agreed to
- Ensure standards are met in the process
- Use time over the next two days efficiently

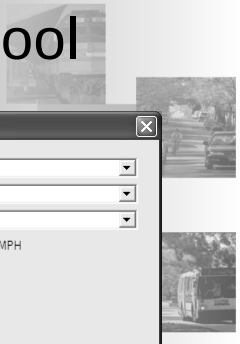
Project Work Plan

- Aggressive project schedule
- Approximately 20 months
- Coordination sensitive
- Incorporates project team input
- Incorporates peer review input
- Project results in valuable regional tool

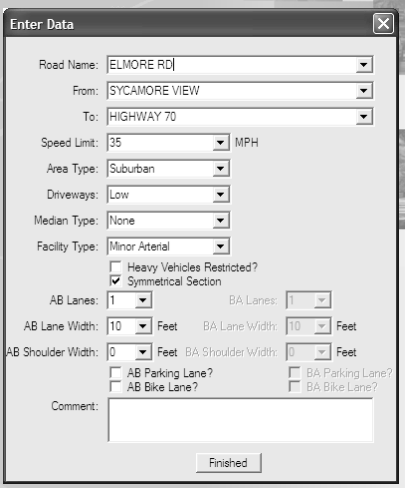
Roadway Network Development

- Using network provided by MPO (with some cleaning)
- Developed data collection tool in TransCAD to enter in network attribute data
- Collecting street data for all streets in network (through TRIMS and windshield data)

Network Collection Tool



- Allows for data entry in the field by a two person team
- Can copy and paste data from one link to another
- Helps to minimize coding errors

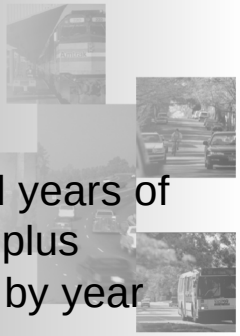


TRIMS Image Data

Roadway Network Development

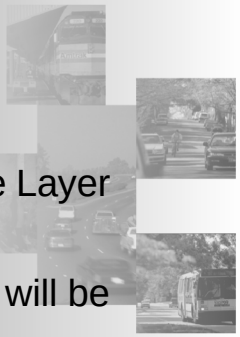
- Coordination with TAZ development to ensure appropriate level of detail for both
- Will develop centroid connectors in coordination with local staff
- Centroid connectors will indicate auto/non-auto access
- Using aerial photography and measurement data to clean interchanges in network

Roadway Network Development



- One TransCAD file will contain all years of development – baseline, existing plus committed, long range plan, etc., by year
- Network will contain “link-dating” that indicates when a particular section will open (or close)
- Changes in network carry over to all potential scenarios and years

Roadway Network Quality Control



- TransCAD tools, such as “Check Line Layer Connectivity” will be used
- Trip path tests and test loadings also will be used to identify network issues
- Plots with network attributes (lanes, speeds, median type, etc.) will also be submitted for review
- Checks against available aerial photography

Development of TAZ Structure

- Expansion of prior zonal coverage
  - In the north (Tipton County)
  - In the east (Fayette County)
  - In the south (DeSoto County)
- Census TIGER Line files
- Geographic features
- Transportation facilities

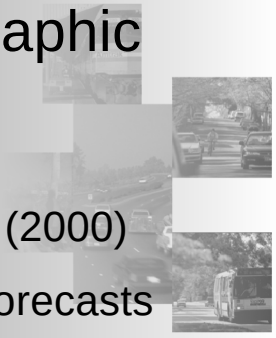
Development of TAZ Structure

- Land use consistency
  - Trip generators
  - Trip attractors
- Parking vs. Employment
- Existing land uses and zoning
- Evaluation of future land use plan

Development of TAZ Structure

- Special generators
- Census boundaries
  - Tracts (suburban/rural)
  - Block groups (urban/suburban)
  - Blocks (urban)
- Centroid connectors and the network

Land Use and Demographic Data Forecasts



- Development of Baseline Data (2000)
- Economic and Demographic Forecasts
- Forecasting Sequence
- Review Process

Development of Baseline Data

- Population and Household Variables
  - Use data from Census 2000 (SF1, SF3)
  - Match Census geography to TAZs
- Employment Variables
  - Use 2000 at-place employment data
  - Reconcile using BLS
  - Group into generalized industry categories (NAICS)

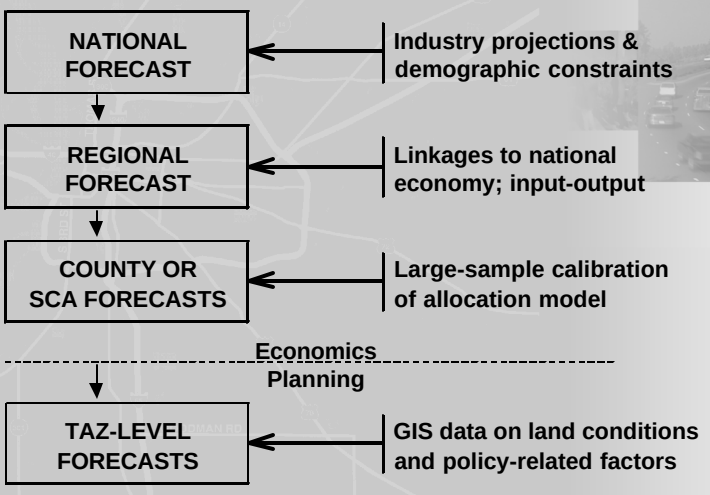
Development of Baseline Data

- 2004 Estimation
  - Consultation with planning staff
  - Comparison with available data (e.g., building permits)

Economic and Demographic Forecasts

- Regional forecasting will be done by regional economist Thomas Hammer, PhD
- TAZ allocation will be completed by planners Jane Dembner and Raman Bhatia of HNTB

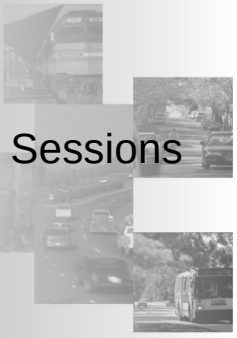
Hierarchical Forecasting Sequence



Allocation to TAZs

- Sub-County Area Forecast as Control Totals
- Decision Rules for Allocation
  - Amount of available land for development
  - Environmental constraints
  - Zoning and future plans
  - Accessibility
  - Agglomeration
  - Other factors
- Reasonableness Check and Adjustment

Review Process



- Five Steering Committee Review Sessions
  - Base Year Data
  - Regional Forecasts
  - Sub-County Area Forecasts
  - Draft TAZ Allocation
  - Final TAZ Allocation

Trip Generation/Trip Production Models

- Home Based Work (HBW)
- Home Based School (HBSch)
- Home Based Shop (HBShop)
- Home Based University (HBUniv)
- Home Based Social/Recreational
- Home Based Other (HBO)
- Home Based Pickup/Dropoff

Trip Generation/Trip Production Models

- Non-Home Based Work (NHBW)
- Non-Home Based Other (NHBO)
- External-Internal/Internal-External/External-External

1998 Household Survey

- Conducted in the Fall of 1998
- 2,526 Households
- 6,438 Persons
- 19,815 Trips
- 26,750 Activities

Trips by Purpose

Tentative Trip purpose definition	Frequency	Percent
Home Based Work	3253	16.4
Home Based Other JTW	1280	6.5
Home Based Other Non-JTW	4705	23.7
Home Based School JTW	11	.1
Home Based School Non-JTW	2127	10.7
Home Based Shopping JTW	205	1.0
Home Based Shopping Non-JTW	1311	6.6
Home Based University JTW	42	.2
Home Based University Non-JTW	307	1.5
Home Based Soc-Rec JTW	92	.5
Home Based Soc-Rec Non-JTW	1176	5.9
Non-Home Based JTW	1675	8.5
Non-Home Based Work Related	264	1.3
Non-Home Based Non-Work	3363	17.0
Total	19811	100.0
Missing	4	.0
Total	19815	100.0

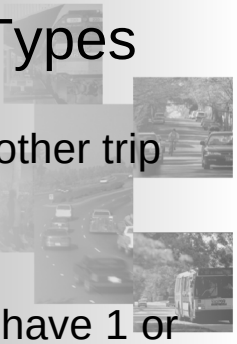
Passenger or Driver

	Frequency	Percent	Valid Percent	Cumulative Percent
Traveler	14562	73.5	73.5	73.5
Passenger	5249	26.5	26.5	100.0
Total	19811	100.0	100.0	
Missing	4	.0		
Total	19815	100.0		

Survey Modes

Mode	Frequency
Walk/WheelChair	1,139
Bicycle	47
School Bus	722
Public Bus	376
Passenger	5,248
Driver	12,225
Taxi/Limousine	20
Other	34
Refused	4
Total	19,815

Trip Production Model Types



- Cross classification tables for all other trip purposes
- HBW Logit utility choice model to determine home based trips that have 1 or more stops en route to work

Special Generators

- Memphis International Airport
- FedEx Operations at Memphis International Airport
- FedEx Headquarters in Collierville
- Graceland

External Trips

- External to Internal trips based on Southeast Michigan Council of Governments External-Internal Model
- External to External trips based on Synthesized Table from TRB 365

Cross Class Data

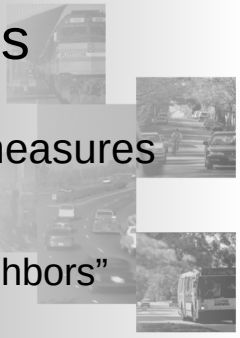
		Number of people in the household - 4 categories				
		1	2	3	4+	Total
Categorised number of workers	0	798	959	272	550	2,579
	1	1,319	1,661	1,469	3,516	7,965
	2	0	2,147	2,060	3,840	8,047
	3+	0	0	337	893	1,230
Total		2,117	4,767	4,138	8,799	19,821

		Number of Vehicles					
		None	1	2	3	4+	Total
Categorised number of workers	0	532	1,244	696	81	26	2,579
	1	600	3,171	3,372	479	343	7,965
	2	223	1,405	5,115	919	385	8,047
	3+	84	115	391	249	391	1,230
Total		1,439	5,935	9,574	1,728	1,145	19,821

Trip Distribution

- Develop impedance matrices
- Develop model estimation data set
- Estimate the logit destination choice models
- Perform model validation

Impedance Matrices



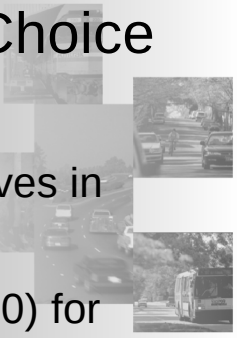
- Will test composite impedance measures
- Intrazonal utility - options
  - Impedance based on “nearest neighbors”
  - Function of zone area
  - Dummy variable based on area type
- Terminal times
  - Based on area type

Destination Choice Model

$$\text{Prob}(i) = \frac{\exp(U_i)}{\Sigma \exp(U_j)}$$

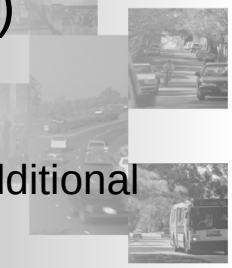
- Alternatives are destination zones
- Utilities are functions of impedance from origin, attractions (size variable), socioeconomic variables

Estimating Destination Choice Models



- Cannot include all zonal alternatives in estimation data sets
- Need to sample destinations (~ 40) for each observation
  - Chosen zone
  - Random sample of other zones

Intermediate Stop Models (for Indirect Work Trips)



- Multinomial logit models
- Impedance measure based on additional time between origin and primary destination
- Can consider limiting choice set of zonal alternatives

Mode Choice

- Prepare model estimation data set
- Determine candidate variables
- Estimate multinomial logit models
- Test nested model structures

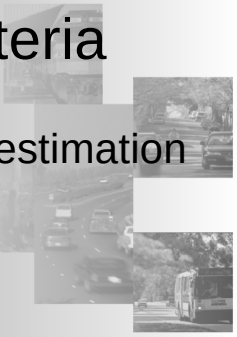
Model Estimation Data Set

- Household survey data set
- Transit on-board survey
- Level of service data – network skims

Transit Path Building

- Need to define:
  - Auto operating costs
  - Auto occupancy levels for highest category
  - Initial weights for OVT, cost components
- No minimums/maximums in skims (recent FTA guidance)
  - Need to consider non-linear functions

Variable Definition Criteria



- Must be available in data set for estimation
- Must be available in application
- Must be available for forecasting

Modal Alternatives

- Walk/bicycle
- Transit – auto access
- Transit – walk access
- Drive alone
- HOV (occupancy levels to be determined)

Model Estimation

- Determine whether coefficients need to be constrained – need to consider:
  - Reasonableness
  - Relationships among coefficients
  - Experience from other models
  - FTA guidelines
- Nesting structures – test alternatives

Truck Model Development

- Quick response Freight Manual procedures
- Observed counts to calibrate generation rates
- Matrix Estimator process for distribution calibration

Truck Trip Generation

Generator	Commercial Vehicle Trip Destinations (or Origins) per Unit per Day			
	Four -Tire Vehicles	Single Unit Trucks (6+ Tires)	Combinations	TOTAL
Employment: *				
• Agriculture, Mining and Construction	1.110	0.289	0.174	1.573
• Manufacturing, Transportation, Communications, Utilities and Wholesale Trade	0.938	0.242	0.104	1.284
• Retail Trade	0.888	0.253	0.065	1.206
• Office and Services	0.437	0.068	0.009	0.514
Households	0.251	0.099	0.038	0.388

Truck Trip Distribution

$$V_{ij} = \frac{O_i D_j F_{ij}}{\sum_{j=1}^{n} D_j F_{ij}}$$

Four-tire commercial vehicles:

$$F_{ij} = e^{-0.08 * t_{ij}}$$

Single unit trucks (6+tires):

$$F_{ij} = e^{-0.1 * t_{ij}}$$

Combinations:

$$F_{ij} = e^{-0.03 * t_{ij}}$$

- Four-tire commercial vehicles – 40 minutes
- Single unit trucks (6+tires) -- 30 minutes
- Combinations – 200 minutes

Truck Time of Day Considerations

Hour		Commercial Vehicles		
From	To	Four-Tire Trucks	Single Units (6+ tires)	Combinations
12	1	0.7%	0.7%	2.3%
1	2	0.4%	0.6%	1.8%
2	3	0.4%	0.6%	1.5%
3	4	0.4%	0.5%	1.7%
4	5	0.6%	1.1%	2.3%
5	6	2.0%	3.0%	3.7%
6	7	6.9%	5.0%	4.3%
7	8	6.6%	7.3%	6.0%
8	9	6.4%	7.2%	5.1%
9	10	5.2%	7.8%	7.1%
10	11	5.7%	7.0%	6.3%
11	12	5.4%	7.5%	6.8%
12	1	5.5%	6.8%	6.9%
1	2	5.8%	7.1%	6.3%
2	3	6.4%	7.7%	6.2%
3	4	7.8%	7.7%	5.3%
4	5	8.6%	6.6%	5.1%
5	6	7.1%	5.1%	4.0%
6	7	5.8%	3.5%	3.9%
7	8	3.3%	2.4%	3.0%
8	9	2.9%	1.6%	2.9%
9	10	2.6%	1.3%	2.6%
10	11	2.0%	1.0%	2.5%
11	12	1.3%	1.0%	2.3%
Total		100.0%	100.0%	100.0%

Time of Day Modeling

- Placement in Model Stream
  - After Trip Generation, prior to Distribution
- Four time periods
  - AM, Mid-Day, PM, and Off-Peak
- Duration and time to be based on available data

Assignment

- All-or-Nothing Pre-Load
  - Heavy Commercial Vehicles
  - External-External Trips
- Equilibrium Multi-Class Assignment
  - Autos and Light Trucks
- Pathfinder Transit Assignment

Model Calibration and Validation

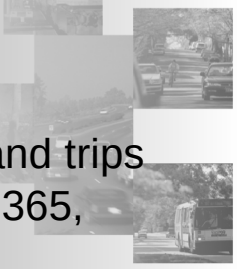
- Validation standards memo to be prepared and approved by MPO
- All model components to be validated

Model Validation Checks

Model input data

- Use of GIS to socioeconomic and network data
- Comparison of socioeconomic data to other sources
- Network path, connectivity, other reasonableness checks

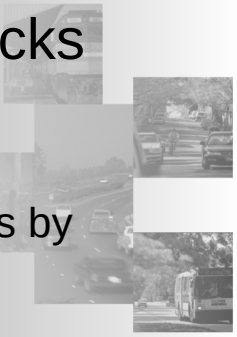
Model Validation Checks



Trip generation

- Comparison of trips by purpose and trips per demographic unit to NCHRP 365, NHTS, and other national values
- Balance between attractions and productions

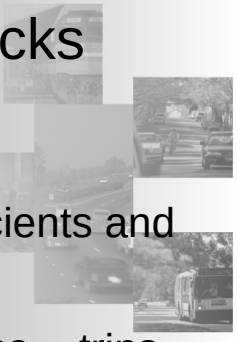
Model Validation Checks



Trip distribution

- Trip length frequency distributions by purpose
- District level O-D
- Intrazonal trips by purpose

Model Validation Checks



Mode choice

- Reasonableness of model coefficients and relationships among them
- Target matrix for each trip purpose – trips by mode and market segment
- Sensitivity checks (elasticities)

Model Validation Checks

Trip assignment

- VMT by functional class
- VMT by geographic market segment
- % RMSE check
- Screenlines/cutlines
- Transit volumes by route group

Development of Future Year Models

- Existing plus committed (EPC) projects
- Develop EPC networks
  - 2020
  - 2030
- Scenario Management
  - One layer
  - "Born-On" and "Expiration" Dates
  - "Out" Folder for All Output Files

Development of Future Year Models

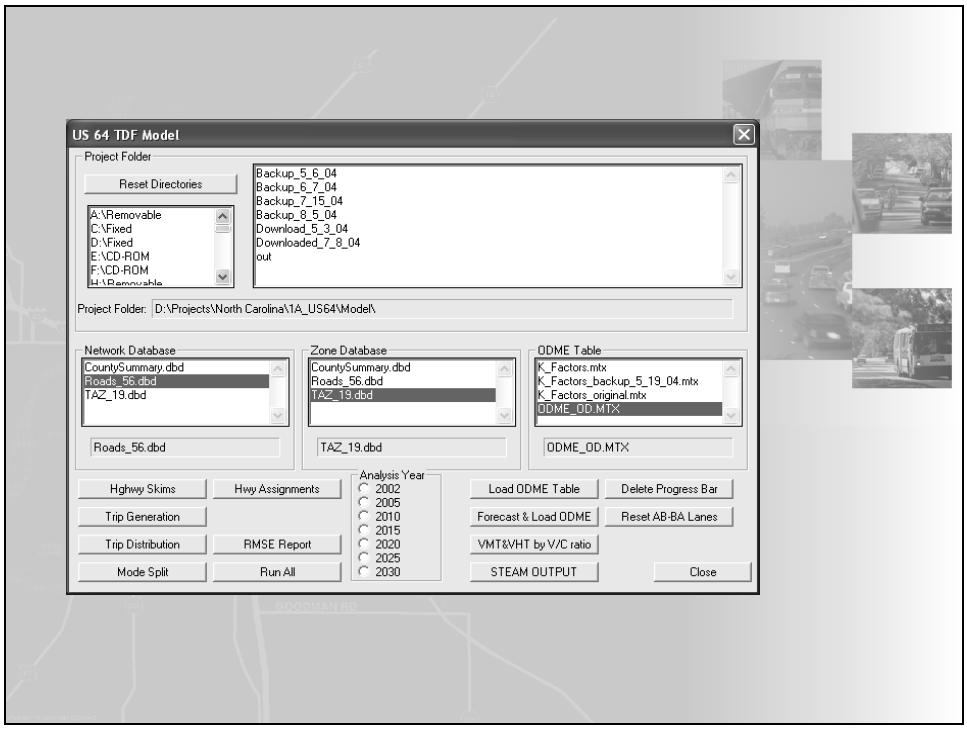
- Develop interim and horizon year socio-economic forecasts
- Develop interim and horizon year transit ridership forecasts
- Develop freight movement forecasts
- Run interim and horizon year assignments

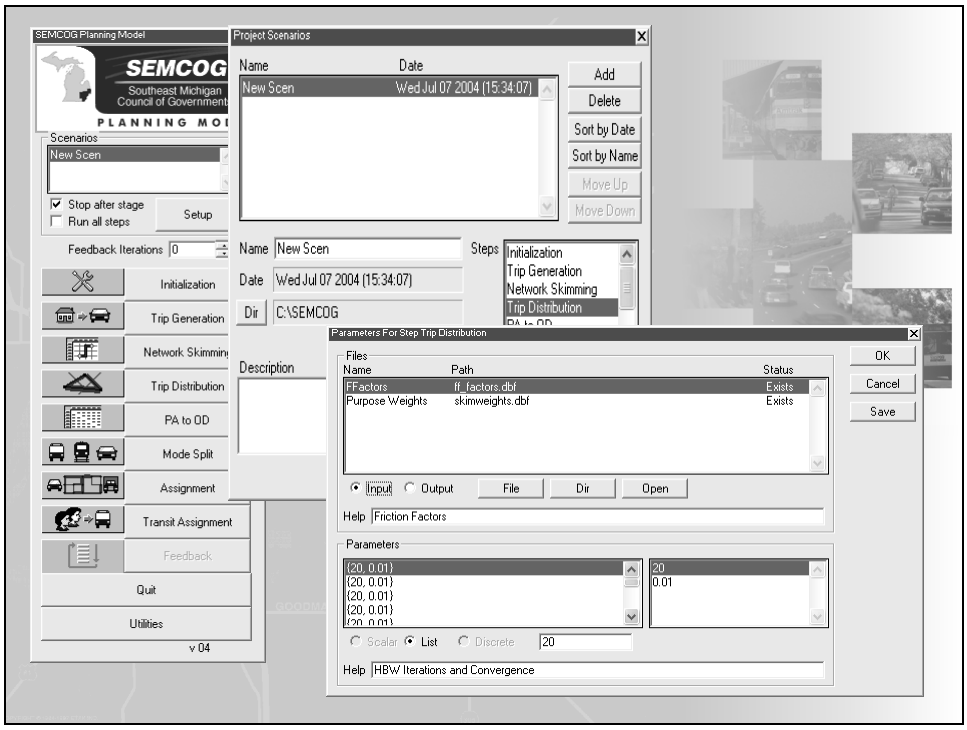
Development of Future Year Models

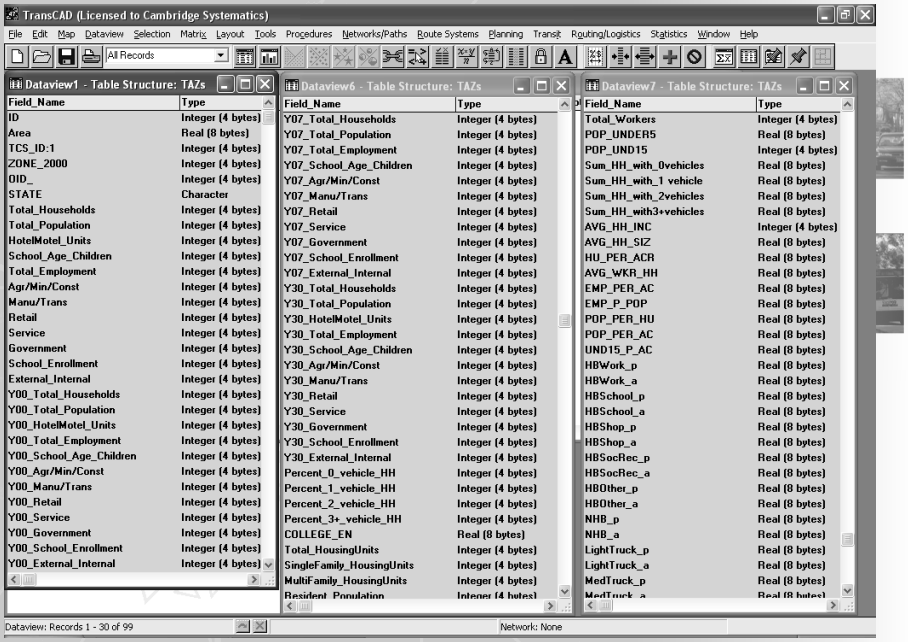
- EPC capacity and LOS analysis
- Infrastructure deficiency analysis
- Recommended deficiency improvements
  - Short-term (0 – 5 years)
  - Mid-term (5 – 15 years)
  - Long-term (15 – 25 years)

Model Automation

- User Interface to step through model or run entire model suite
- Allow user to change “some” model parameters and variables
- Scenario management capability
- Output in common data exchange formats
- Meaningful execution reports


US 64 TDF Model
Project Folder
Reset Directories
Backup_5_6_04
Backup_6_7_04
Backup_7_15_04
Backup_8_5_04
Download_5_3_04
Downloaded_7_8_04
out
A:\Removable
C:\Fixed
D:\Fixed
E:\CD-ROM
F:\CD-ROM
Project Folder: D:\Projects\North Carolina\1A_US64\Model\
Network Database
CountySummary.dbd
Roads_56.dbd
TAZ_19.dbd
Roads_56.dbd
Zone Database
CountySummary.dbd
Roads_56.dbd
TAZ_19.dbd
TAZ_19.dbd
ODME Table
K_Factors.mtx
K_Factors_backup_5_19_04.mtx
K_Factors_original.mtx
ODME_OD.MTX
ODME_OD.MTX
Analysis Year
2002
2005
2010
2015
2020
2025
2030
Hghwy Skims
Hwy Assignments
Trip Generation
Trip Distribution
RMSE Report
Mode Split
Run All
Load ODME Table
Delete Progress Bar
Forecast & Load ODME
Reset AB-BA Lanes
VMT&VHT by V/C ratio
STEAM OUTPUT
Close


SEMCOG Planning Model
SEMCOG
Southeast Michigan Council of Government
Scenarios
New Scen
Stop after stage
Run all steps
Setup
Feedback Iterations 0
Initialization
Trip Generation
Network Skimming
Trip Distribution
PA to OD
Mode Split
Assignment
Transit Assignment
Feedback
Quit
Utilities
v 04
Project Scenarios
Name
Date
New Scen
Wed Jul 07 2004 (15:34:07)
Add
Delete
Sort by Date
Sort by Name
Move Up
Move Down
Name New Scen
Date Wed Jul 07 2004 (15:34:07)
Dir C:\SEMCOG
Steps
Initialization
Trip Generation
Network Skimming
Trip Distribution
Description
Parameters For Step Trip Distribution
Files
Name
Path
Status
FFactors
ff_factors.dbf
Exists
Purpose Weights
skimweights.dbf
Exists
OK
Cancel
Save
Input
Output
File
Dir
Open
Help Friction Factors
Parameters
(20, 0.01)
(20, 0.01)
(20, 0.01)
(20, 0.01)
20
0.01
Scalar
List
Discrete
20
Help HBW Iterations and Convergence



Assignment Summary Report

Code	Functional Class	Number of Counts	Mean Count	Mean Load	% Diff	Target	%Within Target	VMT RMSE	VMT %RMSE
1	Interstate	77	37,764	49,743	31.7	+-7%	0	18,979	50.3
2	Expressway	44	44,606	50,844	14	+-7%	13.6	13,663	30.6
3	Principal Arterial 4 Lanes	100	19,065	17,216	-9.7	+-10%	15	8,157	42.8
4	Principal Arterial 2 Lanes	67	10,211	10,811	5.9	+-10%	26.9	4,506	44.1
5	Minor Arterial	163	4,632	3,332	-28.1	+-15%	13.5	3,377	72.9
6	Collector	244	9,027	8,815	-2.3	+-25%	13.9	5,531	61.3
All		695	14,991	16,125	7.6		13.7	8,707	58.1

Volume	Links With Counts	Mean Count	Mean Load	% Diff	% Target	%Within Target	Volume RMSE	Volume %RMSE
<1,000	29	644	1,216	88.8	+-60%	58.6	1,031	160
1,000-2,499	52	1,780	2,417	35.8	+-47%	40.4	2,126	119.5
2,500-4,999	116	3,625	3,969	9.5	+36%	34.5	2,034	56.1
5,000-9,999	157	7,284	6,396	-12.2	+-29%	33.8	2,813	38.6
10,000-19,999	179	14,289	13,239	-7.4	+-25%	47.5	2,486	17.4
20,000-29,999	65	25,503	27,848	9.2	+-22%	41.5	12,624	49.5
30,000-39,999	44	33,304	42,359	27.2	+-15%	29.5	27,929	83.9
40,000-49,999	23	46,590	62,043	33.2	+15%	0	10,700	23
50,000-59,999	10	52,302	72,367	38.4	+-10%	0	25,348	48.5
60,000-69,999	6	68,010	50,248	-26.1	+-10%	16.7	31,850	46.8
70,000-79,999	12	71,758	80,574	12.3	+-7%	50	6,155	8.6
>89,000	2	99,376	59,526	-40.1	+-7%	0	12,194	12.3
All	695	14,991	16,125	7.6			9,356	62.4

Training

- On-Site Training
  - Stakeholder Participants
  - Two training sessions
  - Duration
  - Topics

Documentation

- Technical Memoranda
- Model Development Methodology
- User's Guide